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Research Note

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INSECT-CAUSED LOSS TO WESTERN WHITE PINE CONESBurton V. Barnes, R. T. Bingham,^{1/} and John A. Schenk^{2/}

ABSTRACT

Insects of three genera, Conophthorus, Dioryctria, and Eucosma, have caused severe loss to cone crops of western white pine in two areas in northern Idaho. The western white pine cone beetle, Conophthorus monticolae, destroyed more than 90 percent of the cones on 12 trees from one area during a 6-year period. At a second locality, larvae of Dioryctria abietella and Eucosma rescissoriana infested 19 percent of the cones on 54 trees in a relatively good seed year and 78 percent in the following, but relatively poor, seed year.

NATURE AND SIGNIFICANCE OF LOSSES

Insect-caused loss to cones and seeds of forest trees is a serious problem in reforestation. Such losses of cones seriously hamper ever-increasing planting programs and efforts to develop genetically better seed. Allen and Coyne (1956), Christisen (1955), Downs and McQuilkin (1944), Ebel (1961), Fowells and Schubert (1956), Hoekstra (1956), Johnson and Heikkinen (1958), Merkel (1961), Miller (1914, 1915), and Stevens (1957) have cited loss due to various cone and seed insects for both hardwood and coniferous species.

Insects hamper both reforestation and tree improvement by destroying or damaging cones and seed that are vital to such programs (Allen and Coyne, 1956; Wright, 1959; and Wright and Gabriel, 1957). Records from the western white pine research program illustrate the immediate need for control measures against cone insects and show the staggering cone loss sustained locally over a period of several years.

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Insect-caused loss to cone crops is well recognized by persons working with western white pine, but records of the amount and extent of damage are scarce. Haig, Davis, and Weidman (1941) reported sporadic--sometimes severe--losses and noted that collecting cones for the planting program had been difficult because of widespread insect damage. Williamson's study (1961) of insect damage to western white pine cones in northern Idaho showed that the greatest portion of damage was caused by Conophthorus monticolae.^{3/} Lesser amounts of damage were caused by Dioryctria abietella (D. & S.) (= D. abietivorella (Grote)) and Eucosma prob. rescissoriana Heinrich.^{4/}

Miller (1915) observed up to 90 percent damage to sugar pine cones caused by the sugar pine cone beetle (Conophthorus lambertianae Hopkins). He predicted that outbreaks could occur in specific centers of infestation anywhere throughout the range of sugar pine. Heavy loss of sugar pine cones on candidate trees caused by Conophthorus beetle attack also has been reported by blister rust control investigators in California (Anonymous, 1959).

Cone Development Related to Insect Attack

Female strobili of western white pine develop and are pollinated in June and July (Bingham and Squillace, 1957) and overwinter as small, green cones. During the following spring and summer the cones complete their development and attain full length (though immature) by July 15; mature cones shed seeds from late August through September. Species of Conophthorus, Dioryctria, and Eucosma infest, damage, and destroy both cones and seeds of western white pine. C. monticolae attacks cones early in the spring of the second year and causes cone deformity and abortion (Keen, 1958; Williamson, 1961). Larvae of Dioryctria and Eucosma feed indiscriminately on cone scales and seeds from June to September as the cones mature.

TYPES OF INSECT LOSSES

For simplicity, cone crop losses can be grouped into three types: (1) strobilus abortion and overwinter loss (including mechanical damage, frost, and cutting by squirrels), (2) spring loss, chiefly caused by Conophthorus monticolae, and (3) summer loss caused by Dioryctria and Eucosma. Damage types 1 and 2 typically destroy the entire cone; summer feeding larvae (type 3) damage only a portion of the cone--often less than half of it.

Overwinter Losses

An estimate of overwinter loss is available from western white pine trees in the Cathedral Peak seed production area (elevation 4,100 feet), Coeur D'Alene National Forest. In June 1960, 550 female strobili were counted on four representative whorls of 54 trees. In June 1961, 91 percent of these strobili were healthy and continuing their development. Very little damage from Conophthorus beetles was observed.

^{3/} Personal communication, D. Leroy Williamson, Texas Forest Service, Woodville, Texas.

^{4/} Specimens identified by William E. Miller, Lake States Forest Experiment Station and Prof. John A. Schenk, University of Idaho.

Spring and Summer Losses

If shoots bearing cones are covered with cloth bags in early spring, both spring and summer losses can be prevented. Controlled pollination shows that when cones are bagged, more than 75 percent of the strobili pollinated develop into mature, uninfested cones (table 1). Part of the 25-percent loss probably occurs because not all strobili can be bagged early enough to prevent all loss due to Conophthorus beetles. Another portion of this loss may be attributed to the artificial pollination process (pollination failure and mechanical breakage).

Table 1.--Mature uninfested cone yield under controlled pollination and cone bagging, 1951-1955^{1/}

Area	Elevation	Trees	Total strobili control pollinated	Strobili producing mature uninfested cones
	<u>Feet</u>			<u>Percent</u>
Crystal Creek (Benewah Co.)	2,950	12	533	73.4
Middle Fork St. Maries River (Shoshone Co.)	2,900	2	41	82.9
Gold Center (Shoshone Co.)	2,950	4	78	69.2
White Rock (Shoshone Co.)	5,000	4	242	81.0
Lower Elk Creek (Clearwater Co.)	3,000	3	163	74.8
			<hr/> 1,057	<hr/> 75.4

^{1/} Pollinations made during breeding program of blister rust resistance project at Moscow, Idaho.

Butterfield Meadows.--Cone production records were kept from 1955 through 1960 in connection with a study of flower stimulation on the St. Joe National Forest near Elk River, Idaho. Counts of strobili were made from 1956 to 1960. Strobili and cones were counted (except in 1955) in late June or early July, after the peak attack by Conophthorus beetles. Insects (chiefly C. monticolae) destroyed 90 percent of the total cone crop by July during the 6-year period (table 2). On an average per-tree-per-year basis, only five uninfested cones persisted until July. Whether this remaining 10 percent uninfested cones survived further insect ravages is unknown, but seems very unlikely.

Table 2.--Insect infestation in western white pine cones at Butterfield Meadows, St. Joe National Forest

Year	Cones counted ^{1/}	Infested cones	Average uninfested cones per tree
		<u>Percent</u>	
1955	340	82	5
1956	80	44	4
1957	287	47	13
1958	593	95	3
1959	1,528	98	2
1960	599	97	1
	<hr/> 3,427	<hr/> 90	<hr/> 5

^{1/} Cones counted from 12 trees in late June or July.

Cone production and insect attack are erratic in magnitude (table 2). Records over a somewhat longer period are needed to determine the relationship between size of cone crop and insect population. Apparently, the Conophthorus population was building up from 1955 until 1957; thereafter Conophthorus beetles destroyed nearly all cones.

At the time of the strobilus and cone count, it was noted that some infested cones (strobili of the previous year) had fallen to the ground, a typical feature of Conophthorus attack since the mature beetles overwinter in cones at the base of the trees (Williamson, 1961). Comparing the strobilus count one year with the cone count the following year during the period 1956-1960 showed a discrepancy of 1,231 cones, or 36 percent of the total. Many of these unaccounted-for cones undoubtedly were infested and had fallen to the ground. Thus, the 90 percent infested figure is a conservative estimate.

Cathedral Peak seed production area.--In sample plots at the Cathedral Peak seed production area, cone counts and cone collections were made on four whorls of 54 sample trees in thinned and unthinned blocks in 1960 and 1961. In the relatively good seed year of 1960, approximately 10 percent of the cones surviving overwinter loss were infested in the unthinned area, while 22 percent of the cones were infested in the thinned area (table 3). D. abietella and E. rescissoriana had caused most of the damage.

In the relatively poor seed year of 1961, the corresponding damage estimates were 47 percent in the unthinned stand and 85 percent in the thinned stand (table 3); damage was greater in the thinned stand than in the unthinned stand in both years. As expected, infestation was greater when a poor cone year followed the good cone year.

Table 3.--Estimate of insect damage to western white pine cones at Cathedral Peak seed production area

Tree density	1960		1961	
	Total cones ^{1/}	Infested cones ^{2/}	Total cones	Infested cones
		<u>Percent</u>		<u>Percent</u>
Unthinned (approx. 8' x 8')	300	<u>3/10</u>	97	47
Thinned (approx. 25' x 25')	<u>725</u>	<u>22</u>	<u>403</u>	<u>85</u>
	1,025	18.5	500	78

^{1/} Includes sound, insect attacked, squirrel cut, and missing.

^{2/} Includes cones attacked by insects and those missing and presumably infested and fallen to the ground.

^{3/} Perhaps an underestimate since the number of infested cones squirrel cut is not known.

DISCUSSION

Past and continuing studies of infestations of cones and seeds by insects reveal severe losses. They emphasize urgent need for (1) additional information about the insects and for (2) development of control measures.

All insects responsible for damage should be identified and their life histories determined. Then possibly control practices could be prescribed and tested. The relative importance of each insect should be determined--particularly since C. monticolae causes loss of the entire cone, while D. abietella and E. rescissoriana cause only partial, but as yet undetermined, loss. We are becoming better informed about severity of seed loss in local areas, but we need to know how severe loss is throughout the western white pine area. Finally, within the framework of a damage survey, we urgently need to know the relation of the amount of damage caused by each pest to environmental factors (elevation, aspect, and climate) and management practice (density regulation).

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